ABSTRACT

The aboveground biomass of forests is an important indicator of its productive and carbon sequestration capability. The accuracy of earth observation data based aboveground biomass estimation methods is increasing steadily with the advances made in machine learning algorithms and the availability of data from state of the art satellite sensors. However, the applicability of these datasets and methods remains relatively unexplored for the tropical forests of India. In this thesis, different pathways were examined for the aboveground biomass estimation of two Indian tropical forest sites by using different satellite data and machine learning algorithms. The canopy height of tropical forests shows a good correlation with its biomass. Therefore, canopy height models for two separate sites were established at first using different satellite data. GLAS data-based models establish through multiple linear regression displayed low accuracy in estimating canopy height with an RMSE of 14.29 m for the Western Ghats. Sentinel data derived parameters proved to be a good indicator for the canopy height of Bhitarkanika WLS mangroves when used in a machine learning model. The random forest model showed an RMSE of 1.57 m, while the symbolic regression-based model had an RMSE of 1.48 m. Established semi-empirical models like Water Cloud Model or Interferometric Water Cloud Model did not perform well in estimating biomass of mangroves while using Sentinel-1 data. It showed a very high RMSE of 158.5 Mg/ha with an R^2 value of 0.24 between ground measured and predicted biomass. However, modern machine learning algorithms like deep learning works much better in the same context. The use of machine learning improves the RMSE up to 94.098 Mg/ha, with a maximum R^2 of 0.42 between field-measured and predicted biomass. Synergistic use of data from multiple sensors shows to improve the aboveground biomass estimation accuracy for the tropical broadleaved forests of Katerniaghat WLS. The vegetation indices from Sentinel-2 data acted as an excellent predictor of biomass. However, using it together with Sentinel-1 data improved the results to a great extent. A high temporal variation of the satellite-derived parameters can be observed for the Bhitarkanika WLS while using multitemporal datasets. The primary reason behind this variation can be traced back to the rainfall pattern for the study area. It was observed from the study that the inclusion of multi-temporal features improved the accuracy from 79.007 Mg/ha to 71.279 Mg/ha. Correlation between field-measured and predicted biomass also improved significantly. The result of this study will encourage the use of machine learning algorithms and datasets from the latest sensors for improved biomass estimation of Indian tropical forests.